

# THE DRAGONFLIES (ODONATA) OF BURMA AND LOWER SIAM.—I. SUBFAMILY CALOPTERYGINÆ.

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This series of papers is based on three collections: First, a collection belonging to the United States National Museum made by Dr. W. L. Abbott in Lower Siam; second, a collection owned by the Philadelphia Academy of Natural Sciences made by Mrs. A. V. B. Crumb, presumably in the vicinity of Toungu, Burma; and third, a collection made for me by Mr. R. A. Earnshaw in the Karenni and Toungu districts, Burma. Mr. Earnshaw writes that his specimens were mostly taken along mountain streams and at elevations of from 4,000 to 6,000 feet. In the future I hope to receive from Mr. Earnshaw some notes on seasonal distribution of the dragonflies of these districts for publication in this series of papers.

The first two collections mentioned above I have received for study at the suggestion of Dr. Philip P. Calvert, to whom the Siamese collection had already been loaned, this loan being transferred to myself. I am indebted in the preparation of this paper to Prof. James G. Needham, in whose laboratory and under whose direction the wing photographs, reproduced in this article, were made from material taken from the collections before me.

The purpose of this study is twofold: First, to identify and record the species in the three collections, offering such notes as may suggest themselves and describing any forms that appear to be unknown. The bibliographical references to be found in Kirby's Catalogue<sup>a</sup> and in more recent papers, especially Krüger's Odonaten von Sumatra<sup>b</sup> and papers by Laidlaw on dragonflies of the Malay Peninsula,<sup>c</sup> make

<sup>a</sup> A Synonymic Catalogue of Neuroptera Odonata, or Dragonflies. With an Appendix of Fossil Species. By W. F. Kirby. London, Gurney & Jackson. 1890.

<sup>b</sup>Stett. Ent. Zeit., LIX, 1898, pp. 64-139, 267-331; LX, 1899, pp. 321-338; LXIII, 1902, pp. 58-193; LXIV, 1903, pp. 248, 292.

<sup>c</sup>On a collection of dragonflies made by the Skeat expedition in the Malay Peninsula in 1899-1900, by F. F. Laidlaw. Proc. Zool. Soc. London, 1902, I, pp. 63-92, pls. v, vi; II, pp. 381-389; Fasciculi Malayenses, Zoology I, 1903, pp. 189-200.

other than occasional references in this matter unnecessary. Second, to incorporate in the papers keys and, if necessary, other descriptive matter sufficient to enable anyone interested to determine for himself the species known to occur in the regions under consideration. However, but comparatively few localities have been visited by collectors; consequently in these papers great incompleteness, when compared with the list of species eventually to be found, must be expected. "May its incompleteness be soon shown by a multitude of new discoveries."

De Selys in 1891<sup>a</sup> recorded 88 odonates from Burma, based on collections made by Leonardo Fea, and numbering more than 750 specimens. The localities visited by Fea are as follows: Teinzo, a village about 24° 30' north latitude, northeast of Bhamo, on the Moolay River, a tributary of the Irawadi; Bhamo and Shwegoo on the Irawadi; Mandalay on the Irawadi, 22° north latitude; Rangoon and Palon, between 16° and 18° north latitude, on the Irawadi; Toungu, 19° north latitude, on the Sittang River; Leitò, Cobapò, Puepoli, Meteleo, Iado, Taò, and Chialà, villages in the mountainous regions between the Sittang and Salwin valleys; Moulmein, Kokarit, Meetan, Thagatà, and Malewoon, towns between 10° and 17° north latitude. As mentioned elsewhere, the material studied by myself from Burma comes only from the neighborhood of Toungu. Doctor Abbott's collecting in Siam was all done in the province of Trong, Lower Siam.

This paper deals with the subfamily Calopteryginae. De Selys in 1891 listed 11 species from Burma. Twenty-one species are now known from Burma and Siam. The collections before me include 17 of these. This subfamily includes many of the most beautiful dragonflies of the world, iridescent and metallic effects glowing on wings and bodies with the brilliancy of gems. In size they vary from pigmies to giants, but all are delicate insects and often the body is extremely slender. Undoubtedly the study of their habits should attract those to whom the beauties of nature are a continual delight, revealing much of interest and value. In collections of dragonflies from Burma and Siam, as in all collections almost without exception regardless of locality, males are much more numerous than females. In the genera *Euphava* and *Dysphava*, for example, De Selys has commented on the great rarity of females, attributing this to the fact that they have not attracted collectors as have the brighter males. Mr. Laidlaw<sup>b</sup> thinks "that this scarcity in collections is not due to their being overlooked by collectors. I can safely say that I never saw a female of this species (*Dysphava limbata*) or of *Euphava impar*, while the males were at times abundant." But Mr. Laidlaw's argument in no wise invalidates

<sup>a</sup>Odonates de Birmanie, Ann. del Museo Civico di Storia Naturale di Genova, Serie 2a X (XXX), 1891, pp. 433-518.

<sup>b</sup>Proc. Zool. Soc. Lond., Feb. 4, 1902, p. 88.

De Selys's statement, since it is not shown that he, Laidlaw himself, did not overlook the females. His failure to discover them may have been because of one or both of two possible reasons: They may conceal themselves in the vegetation near the haunts of the males, appearing on the wing rarely and then at hours of the day not suspected by the dragonfly collector; or they may habitually frequent retreats in the jungles far from the localities where the males are conspicuous with brilliant wings to attract the collector to the most favorable hunting grounds. There may be other reasons, too, why the females are less known in collections, but the above remarks will indicate that original observations are possible and desirable. In the present paper only imagoes are discussed. Nothing could be more desirable in this connection than a collection of nymphs sufficient to at least allow of the definition of generic characters in immature stages.

KEY TO THE ORIENTAL GENERA OF THE SUBFAMILY CALOPTERYGINÆ (IMAGOES).<sup>a</sup>

ORDER ODONATA (Neuroptera Odonata, Paraneuroptera).

a. Fore and hind wings similar in venational structure; quadrangle present; wing membranule wanting; supplements (veins across wing membrane opposed to principal veins) wanting. Head wide, eyes separated. Males with 2 inferior abdominal appendages; females with genital valves. . . . SUBORDER ZYGOPTERA

b.  $M_3$  separating from  $M_{1+2}$  nearer the nodus than the areculus.

FAMILY AGRIONIDÆ

bb.  $M_3$  separating from  $M_{1+2}$  nearer the areculus than the nodus, or at not more than half the distance from areculus to nodus. . . . . FAMILY CALOPTERYGINÆ

c. Antenodals 2 . . . . . SUBFAMILY LESTININÆ

cc. Antenodals 4 or more. . . . . SUBFAMILY CALOPTERYGINÆ

d.  $M_{1-3}$  and  $M_4$  rising from the middle or near the middle of the areculus, not together from its extreme anterior end.

e. Antenodals of first series not coinciding with those of second series beyond the level of the areculus;  $M_{1+2}$  and  $M_3$  forming a symmetrical fork, or  $M_{1+2}$  continuing the direction of  $M_{1-3}$ ; wings petioled at least one-half way to the areculus; subquadrangle bent at the areculus.

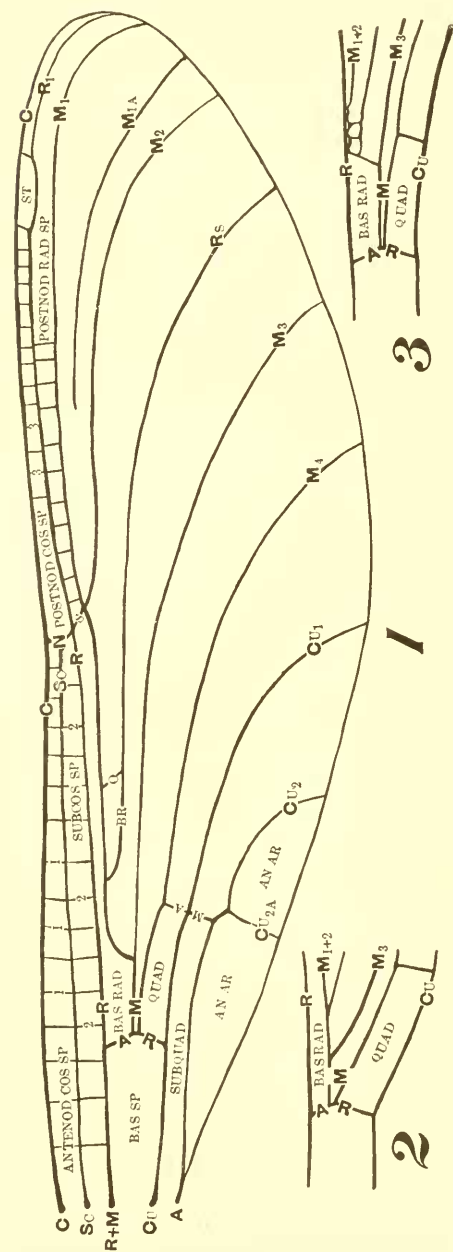
f. Antenodals of second series wanting beyond the level of the areculus; normally 4 antenodals continuous in the first and second series; wings petioled and narrowed nearly to the level of the areculus and half way to the level of the nodus; distance from base of front wing to nodus less than  $\frac{1}{3}$  wing length;  $M_2$  arising beyond the nodus at about the fourth postnodal of the second series; quadrangle about  $\frac{1}{3}$  as long as basal space and with 2 cross veins;  $M_{1a}$  parallel to  $M_1$ ; stigma ovate . . . . . *Deradotta*

ff. Antenodals of second series present beyond the areculus; wings less petioled and the nodus not so retracted.

g. Second antenodal over areculus;  $M_{1-3}$  and  $M_4$  arising from a single point; quadrangle wider proximally. . . . . *Micromerus*

<sup>a</sup>Two genera, *Caliphuca* and *Philoganga*, known to me only from descriptions, are omitted. Neither genus is known from Burma or Siam.

*A*, anal vein (postcostal vein); *ant nod cos sp*, antenodal costal space (antecubital costal space); *an ar*, anal area (postcostal space); *AR*, areculus; *bas rad*, basal radial space; *bas sp*, basal space (basilar space, upper basal cell or median space); *br*, bridge; *C*, costa (costal vein);



FIGS. 1-3.—DIAGRAMMATIC WING OF A DRAGONFLY, SHOWING THE NOMENCLATURE OF THE VENATION.

*Cu*, cubitus (submedian vein); *Cu<sub>1</sub>*, first branch of *Cu* (first sector of the triangle); *Cu<sub>2</sub>*, second branch of *Cu* (second sector of the triangle); *Cu<sub>2a</sub>*, branch of *Cu<sub>2</sub>* (inferior branch of second sector of the triangle); *M*, media (upper and lower sectors of the areculus); *M<sub>1</sub>*, first branch of *M* (apical part of principal sector—extending from subnodus, *S*, to apex of wing); *M<sub>1a</sub>*, long sector between *M<sub>1</sub>* and *M<sub>2</sub>* (ultranodal or postnodal sector); *M<sub>2</sub>*, second branch of *M<sub>1</sub>* (nodal sector); *M<sub>1+2</sub>*, trunk from which arise the first and second branches of *M* (basal part of principal sector—extending from its origin to subnodus, *S*); *M<sub>3</sub>*, third branch of *M* (median sector); *M<sub>4</sub>*, fourth branch of *M* (short sector); *ma*, medioanal link; *N*, nodus (cross vein at end of *Sc*, between *C* and *R*); *O*, oblique vein; *post nod cos sp*, postnodal costal space (postcubital costal space); *post nod rad sp*, postnodal radial space; *quad*, quadrangle (quadrilateral); *R*, radius; *R+M*, radius+media (median vein); *R<sub>1</sub>*, first branch of *R*; *R<sub>s</sub>*, radial sector (subnodal sector); *S*, subnodus; *Se*, subcosta (subcostal vein); *St*, stigma (pterostigma) *subcos sp*, subcostal space; *subquad*, subquadrangle (median space or lower basal cell); *1*, antenodal of first series (antecubital of first series); *2*, antenodal of second series (antecubital of second series or subcostal cross vein); in fig. 1 the antenodals number about 15 and the postnodals about 17. In fig. 2 the basal radial space is open—that is, *M<sub>1+2</sub>* beyond the areculus does not approach *R*; in fig. 1 the basal radial space is partly closed—that is, *M<sub>1+2</sub>* beyond the areculus approaches *R*; and in fig. 3 the basal radial space is closed—that is, *M<sub>1+2</sub>* beyond the areculus reunites with *R*. In figs. 1 and 3, *M<sub>3</sub>* continues the direction of *M<sub>1-3</sub>*; in fig. 2, *M<sub>1+2</sub>* and *M<sub>3</sub>* form a symmetrical fork, or *M<sub>1+2</sub>* continues the direction of *M<sub>1-3</sub>*.

<sup>a</sup> The question arose whether this vein is a branch of *A* or *Cu<sub>2</sub>*. The opinion expressed above is that of Professor Needham, to whom I am also indebted for other suggestions in terminology.

<sup>b</sup> Not labeled on fig. 1.

<sup>c</sup> *M<sub>1-3</sub>* is the upper sector of the areculus. It is the trunk from which arise the first, second, and third branches of *M*, and extends from *AR* to the origin of *M<sub>1+2</sub>*.

- gg. Third antenodal over arculus; <sup>a</sup> M<sub>1-3</sub> and M<sub>4</sub> separate at their origin; quadrangle uniform in width.
- h. Venation simple; secondary sectors reduced in number and length, the longest on either side of M<sub>1a</sub> not rising before the inner side of the stigma; quadrangle with 1 cross vein ..... *Libellago*
- hh. Venation more complex, the longest secondary sector on anterior side, and usually on posterior side of M<sub>1a</sub> rising before the inner side of the stigma; more than one cross vein in the quadrangle. .... *Rhinoceypha*
- ee. Antenodals uniform and undifferentiated (usually more than 20), those of first series largely coinciding with those of second series; M<sub>3</sub> continuing the direction of M<sub>1-3</sub>; wings slightly or not at all petioled; subquadrangle straight or slightly bent at the arculus.
- f. Subquadrangle slightly bent at arculus; basal space at least 1½ times as long as quadrangle; quadrangle with less than 4 cross veins.
- g. Cu<sub>2a</sub> not present; nodus before middle of wing; wings petioled for a short distance; postnodals more numerous than antenodals.
- h. Cross veins reduced, quadrangle and basal radial space free, and subquadrangle with a single cross vein; basal space more than twice as long as quadrangle.
- i. Basal radial space closed ..... *Bayadera*
- ii. Basal radial space partly closed ..... *Anisopleura*
- hh. Quadrangle and basal radial space crossed and subquadrangle with 2 or more cross veins; basal space about twice as long as the quadrangle ..... *Euphaea*
- gg. Cu<sub>2a</sub> present; nodus at middle of wing; wings not petioled; antenodals more numerous than postnodals ..... *Dysphaea*
- ff. Subquadrangle straight; basal space shorter than or only very slightly longer than quadrangle; basal radial space with cross veins; quadrangle with 4 or more cross veins.
- g. Arculus not angled, oblique; M<sub>1-3</sub> and M<sub>4</sub> arising from a single point near posterior end of arculus; quadrangle widest at its distal end; Cu<sub>2</sub> curved strongly posteriorly, Cu<sub>2a</sub> wanting; M<sub>2</sub>, M<sub>3</sub>, Cu<sub>1</sub>, and Cu<sub>2</sub> forked; basal space free; basal radial space closed; stigma wanting ..... *Vestalis*
- gg. Arculus distinctly angled; M<sub>1-3</sub> and M<sub>4</sub> separate at their origin; Cu<sub>2a</sub> present.
- h. Basal space free; stigma present.
- i. Basal space and quadrangle about equal in length, the quadrangle usually with 4 or 5 cross veins ..... *Mnais*
- ii. Quadrangle narrow, about 1½ times as long as basal space, with 10 or more cross veins ..... *Psolodesmus*
- hh. Basal space crossed.
- i. True stigma present; radial sector in hind wing not strongly waved.
- j. Neuration complex; anal area wide, and the hind margin of the wing along this area broadly convex; in the hind wing the area between Cu<sub>1</sub> and Cu<sub>2</sub> at their origin is reticulate.  
*Archineura* (from Kirby's figure) <sup>b</sup>

<sup>a</sup> The middle one of the 3 antenodals in *Rhinoceypha* and *Libellago* is not present in the wing of *Micromerus*, and is not coinciding in the first and second series, unless accidentally.

<sup>b</sup> McLachlan has described both sexes of *Archineura incarnata* from western China, and he questions the correctness of Mr. Kirby's type locality, Fuchau, "although it may have been brought to that port from the interior."

- ij. Anal area simpler, narrower, the hind margin of the wing near the wing base straight or slightly concave; one row of cells between  $Cu_1$  and  $Cu_2$  at their origin.
  - k. Nodus at a point less than  $\frac{1}{2}$  the distance from wing base to stigma ..... *Echo*.<sup>a</sup>
  - kk. Nodus placed beyond the point midway between wing base and stigma ..... *Climacobasis*.<sup>ii</sup>
- ii. Stigma wanting or only a false stigma present; radial sector in hind wing strongly waved. (Subdivided by Förster as follows:)
- j. Four wings of male opaque.
  - k. Cells of basal space for the most part divided ..... *Matrona*
  - kk. Only one or two cells of basal space divided ..... *Matronoides*
  - jj. Front wings of male hyaline ..... *Neurobasis*

I. DEVADATTA ARGYOÏDES (De Selys).

I have seen a single female, collected by Doctor Abbott, Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January-February,

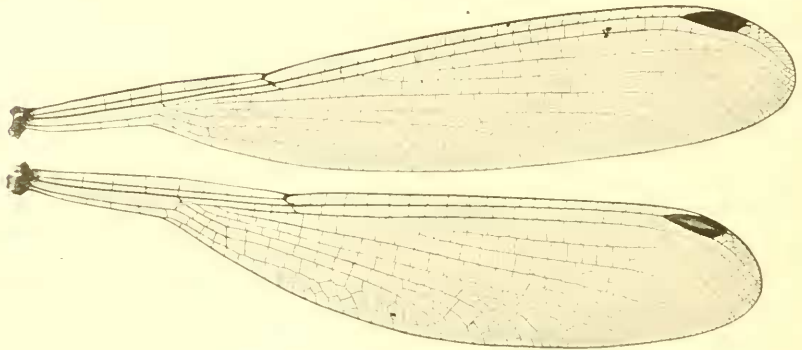


FIG. 4.—WINGS OF FEMALE DEVADATTA ARGYOÏDES FROM SIAM.

1899. This specimen has the abdomen 34 mm. in length and the hind wing 31. The species has been recorded from the Malay Peninsula and Borneo.

<sup>a</sup>*Echo* is known to me only from descriptions and figures, but such differences between it and *Climacobasis* appear to exist in the anal region and in the stigmas of the males that, in so far as the two names have been published, their separation seems to me desirable, at least till a more critical study can be made.

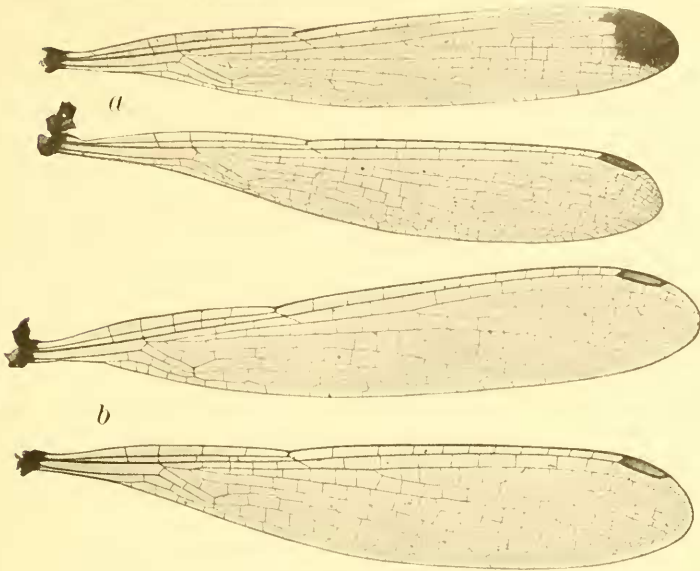


FIG. 5.—WINGS OF MICROMERUS LINEATUS FROM SIAM. *a*, MALE; *b*, FEMALE.

2. MICROMERUS LINEATUS (Burmeister).

Material studied: Trong, Lower Siam, collection U.S.N.M., 25 males, 34 females. Burma, collection P. A. N. S., 4 males; collection Williamson, 2 males.

Abdomen with the pale areas more extensive in younger individuals. De Selys has questioned the specific distinctness of *M. obscurus* Kirby from Hassan Abdal. The dull coloration of the body and basal coloration of the wings in Kirby's specimen certainly indicate a teneral condition, but in the material examined by myself, though a number are very teneral, in all the color pattern of the abdomen indicated in my figures is plainly discernible. So far as I am able to judge from Kirby's figure and description, *obscurus* seems distinct from *lineatus*, though it may not be different from some of the species with abdomens largely pale in color. *M. lineatus* has hitherto been recorded from Penang, Java, Burma, Ceylon, and India.

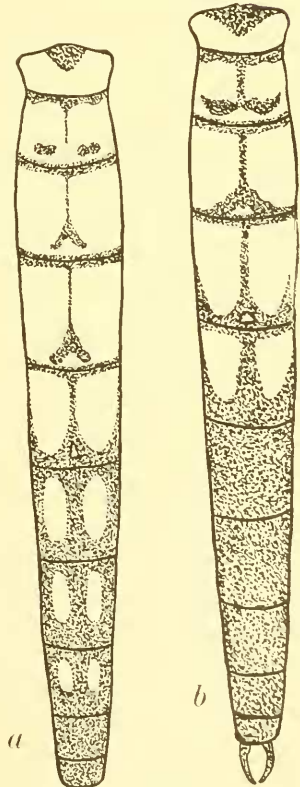


FIG. 6.—COLOR PATTERN OF THE DORSUM OF ABDOMEN OF MICROMERUS LINEATUS FROM SIAM. *a*, TENERAL MALE; *b*, MATURE MALE.

## 3. MICROMERUS AURANTIACUS De Selys.

The collection made by Doctor Abbott contains a single male from Khow Sai Dow Mountain, Trong, Lower Siam, January-February, 1899. Abdomen, 13.5 mm. in length; hind wing, 16.5; opaque spot on front wing, 3.5 in length. Abdomen basally yellow, passing into red apically. Probably the predominance of one of these colors over the other is entirely a matter of age. *M. annandali* Laidlaw, described from a single male from Mabek, Hulu Jalor, seems scarcely distinct from *aurantiacus* originally described from Malacca.

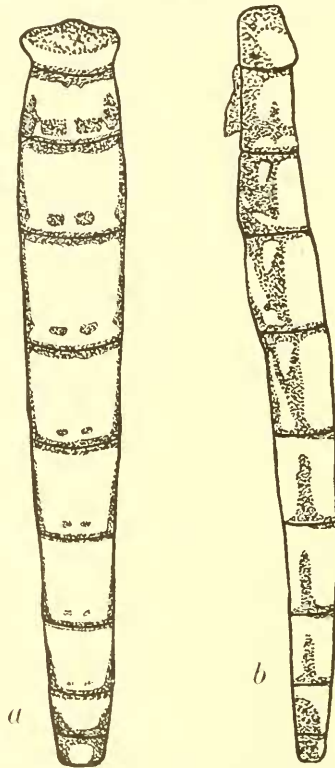


FIG. 7.—COLOR PATTERN OF THE ABDOMEN OF A MALE MICROMERUS AURANTIACUS FROM SIAM.  
a, DORSAL VIEW; b, LATERAL VIEW.

Since the publication of Kirby's catalogue four species of *Micromerus* have been described as new: *M. martinæ* Karsch,<sup>a</sup> from Sumatra; *M. signatus* Krüger,<sup>b</sup> from Java and Penang; *M. affinis* Laidlaw,<sup>c</sup> from Kwala Aring; *M. annandali* Laidlaw,<sup>d</sup> from Mabek, Hulu Jalor. Nineteen specific names have been proposed in this genus, and of these it is remarkable that only one is certainly a synonym.

<sup>a</sup> Ent. Nach., XVII, 1891, p. 243.

<sup>b</sup> Stett. Ent. Zeit., 1898, p. 86.

<sup>c</sup> Proc. Zool. Soc. Lond., Feb. 4, 1902, p. 90.

<sup>d</sup> Fasciculi Malayenses, Zoology, I, Oct., 1903, p. 197.



## 4. LIBELLAGO VITTATA De Selys.

“Bhamo en juin et juillet (Fea).” No specimens of this species are represented in collections before me.

## RHINOCYPHA Rambur.

Dorsal mesothoracic triangular area long, reaching the antealar sinus. Male: wings expanded, anal area beyond the level of the medio-anal link at its widest part at least 3 times as wide as at its narrowest part;  $Cu_2$  not zigzagged before half its length; hind wings with 3 rows of vitreous spots. *Fenestrella* group.

Male. Middle series of vitreous spots on hind wing consisting of 2 spots, the posterior one 7-9 cells wide; apical spot about 10 cells wide.....*cuneata*, *adamantina*

Male. Middle series consisting of 3 spots (often a fourth between the middle and posterior one), the 2 posterior ones homologous with the posterior spot of *cuneata*; apical spot 8 cells or less wide.

Apical spot 4-6 cells wide, entirely under stigma; stigma red, surrounded with black, darker in old individuals.....*fenestrella*

Apical spots 8 cells wide, basally not under the stigma; stigma black, obscure yellowish in the middle.....*quadrimaculata* and *spuria*

Dorsal mesothoracic triangular area short. Male: wings less expanded, anal area less widened;  $Cu_2$  zigzagged for more than half its length.

Male. Apical third of the hind wings dark colored.....*bifurcata*

Male. Apical dark color on hind wings beginning at the nodus.....*ignipennis*

Male. Apical dark color on hind wings beginning at the level of the medio-anal link.....*iridea*

Since the publication of Kirby's catalogue the following species have been described:

*R. turcomi* De Selys,<sup>a</sup> “Patrie: Panay pay (Ile de Zebu).” Described as related to *heterostigma* and *anisoptera*.

*R. iridea* De Selys.<sup>b</sup> Burma: “Leitò en mai; puepoli en juin (Fea).” Described as related to *fenestrata*.

*R. stygia* Förster,<sup>c</sup> “Patrie: Le mont Kina, Batu, au nord de l'île de Borneo.” In wing coloration this species is described as related to *immaculata*.

*R. pagenstecheri* Förster,<sup>d</sup> “Heimat: die Insel Lombok.” Related to *terminata*.

*R. pagenstecheri* subrasse *sumbana* Förster,<sup>e</sup> “Heimat: Patadalu, Sumba-(Sandelholz-)Insel.”

*R. apicalis* Krüger,<sup>f</sup> Described as “*Rhinocyppha bisignata* Hagen! *apicalis* n. sp.” “Heimath: Sumatra, Sinabong (Dohrn).”

<sup>a</sup>Anales de la Soc. Esp. de Nat. Hist., XX, 1891, p. 215.

<sup>b</sup>Ann. del Museo Civico di Storia Nat. di Genova, Serie 2<sup>a</sup>, X (XXX), 1891, p. 492.

<sup>c</sup>Ann. Soc. Ent. Belg., XLI, 1897, p. 210.

<sup>d</sup>Ent. Nachr., XXIII, 1897, p. 333.

<sup>e</sup>Idem, p. 335.

<sup>f</sup>Stett. Ent. Zeit., 1898, p. 79.

*R. selysi* Krüger.<sup>a</sup> "Heimath: Nur Sumatra, Soekaranda (Dohrn)." "Diese neue art gehört zur Gruppe *heterostigma*."

*R. karschi* Krüger.<sup>b</sup> "Heimath: Nur Sumatra, Soekaranda (Dohrn)." "Diese neue art bildet eine neue Gruppe bei *Rhinoocypha* zwischen *heterostigma* und *tincta*."

*R. braueri* Krüger.<sup>c</sup> "Heimath: Nur Sumba (Grelak)." Described as related to *unimaculata* and *stygia*.

*R. hayeni* Krüger.<sup>d</sup> "Heimath: Nur Jolo (Standinger)." Described as belonging to the group *tincta*.

*R. whiteheadi* Kirby.<sup>e</sup> Hainan. Allied to *perforata*.

*R. inas* Laidlaw.<sup>f</sup> Gunong Inas. "Closely allied to *perforata*." "The marks of the hind wing resemble most closely those of *R. whiteheadi* Kirby."

*R. adamantina* Förster.<sup>g</sup> "Heimath ebenfalls Sikkim, ohne genaueren Fundort." Described as most closely related to *quadrinaculata*.

*R. aurentata* Förster.<sup>h</sup> "Heimath: Die Südmolukken-Insel Buru der sie endemisch zu sein scheint." "*R. aurentata* gehört zur *terminata*-Gruppe, die sie mit der *semitincta* verknüpft."

No less than 49 specific names have been proposed in this genus. The tendency recently seems to be to regard many of these as local races, if distinct at all.<sup>i</sup> *R. inas* and *whiteheadi* seem identical with *apicalis*. I can not distinguish *cuneata* and *adamantina* nor *quadrinaculata* and *spuria* so far as descriptions go.

Speaking of the *fenestrella* group, Förster says:

*Rh. quadrinaculata*, *adamantina* von Nord Indien, *spuria* von den Khasia Hills, *cuneata* von Thibet und *fenestrella* von Malakka sind Rassen des *fenestrella*-Typus und gehören zu den brillantesten Insekten der Erde.

To one at all familiar with North American fresh-water fishes, these dragonflies, with gorgeous males and sober females, diminutive members of a family containing many giants, can not but suggest the darters (Etheostominae) of whom Professor Forbes has written:

Although diminished in size \* \* \* they have developed \* \* \* a vigor of life and a glow of color almost unknown among the easier dwellers of the lower lands. \* \* \* Notwithstanding their trivial size, they do not seem to be dwarfed so much as concentrated fishes.

<sup>a</sup>Stett. Ent. Zeit., 1898, p. 81.

<sup>b</sup>Idem, p. 83.

<sup>c</sup>Idem, p. 133.

<sup>d</sup>Idem, p. 135.

<sup>e</sup>Ann. and Mag. Nat. Hist., 7th ser., V, June, 1900, p. 536, pl. XII, fig. 4.

<sup>f</sup>Proc. Zool. Soc. Lond., Feb., 1902, p. 88, pl. vi, fig. 6.

<sup>g</sup>Ann. Mus. Nat. Hungarici, 1903, p. 547.

<sup>h</sup>Idem, p. 547.

<sup>i</sup>Selys, Ann. Soc. Esp., XX, 1891, pp. 213-215, and Förster, Ann. Mus. Nat. Hungarici, 1903, pp. 546, 547.

The dense chalky white pruinescence of the under surface of the tibia of adult males has evidently to do with sex attraction. Laidlaw<sup>a</sup> records the following note for *fenestrella*:

Dances in the air before the female, displaying white surface of tibiae.

In the North American *Calopteryx maculata* there is a definite ventral apical abdominal spot which is shining white in living, fully adult males. This area is displayed by a male at rest by curving the abdomen so that the apex is brought upward and forward, the hind wings meanwhile being fluttered rapidly while the front wings are held motionless. The pruinose white spot thus turned dorsally becomes conspicuous, especially as held between the brilliant black fluttering wings. The extent of pruinescence is often a matter of age, old males of some species being almost entirely pruinose, but the first appearance of this is usually on the dorsum of the thorax and the dorsum of the last abdominal segments, and in many species these areas alone become pruinose. In the *Agrioninae*, where pruinescence is rarer than in the subfamily under consideration, these parts, i. e., dorsum of thorax and last abdominal segments, are in the males usually the most conspicuously colored portions of the insects, while the abdomen of the females of the same species may not be strikingly colored. In species of *Enallagma*, for example, the thoracic markings are very similar in the two sexes, while the abdomen is conspicuously different. It may be noted that the male of these species captures the female by seizing her thorax with his legs, and so holds her till he has fixed his abdominal appendages on her prothorax. The male of *Argia putrida* soon after emergence has the dorsum of the abdomen black. Its congeners in Indiana have the apical segments brightly colored, and when *putrida* reaches sexual maturity the apical segments have become pruinose. The prothorax of many of these species is brightly colored; and the second abdominal segment of the male, which bears the accessory genitalia, has a striking and conspicuous color pattern, serving possibly as a guide to the female in bringing her vulva in contact with the male genitalia. The auricles of the second abdominal segment of males in other subfamilies may serve a similar purpose. In some of the Calopterygidae the basal abdominal segments early assume a decided pruinescence. The pruinose spot on the vertex of the adult male of *Climacobasis modesta* is conspicuous, and an exactly similar spot appears in other species when the pruinescence has come to largely occupy the entire body. In the *Libellulinae* the male and female of many species are nearly identical in color at the time of emergence, while with age the male becomes largely or entirely pale bluish or white pruinose, thus distinguishing the two sexes at the time of their maturity.

<sup>a</sup> Fasciculi Malayenses, p. 169.

## 5. RHINOCYPHA QUADRIMACULATA De Selys.

Material studied: Burma, collection Williamson, 1 male.

This single specimen, which I was disposed to regard as belonging to an undescribed race, has been examined by Professor Förster who writes that it agrees perfectly with specimens from Sikkim in his collection, pronounced *quadrимaculata* by De Selys. This specimen is smaller, rather than larger, than *fenestrella*. It may be described as follows: Abdomen 19 mm.; hind wing 21. Head in front clear shining black, eyes chestnut brown; head above shining black; lateral ocelli orange, a closely adjacent spot external to each ocellus, same size as the ocellus, yellow, and behind these spots, at either end of the posterior ridge of the occiput, is an orange spot; these two last-described spots and the anterior ocellus are at the three angles of an equilateral triangle; tip of second joint of antennæ dull yellow. Prothorax black,

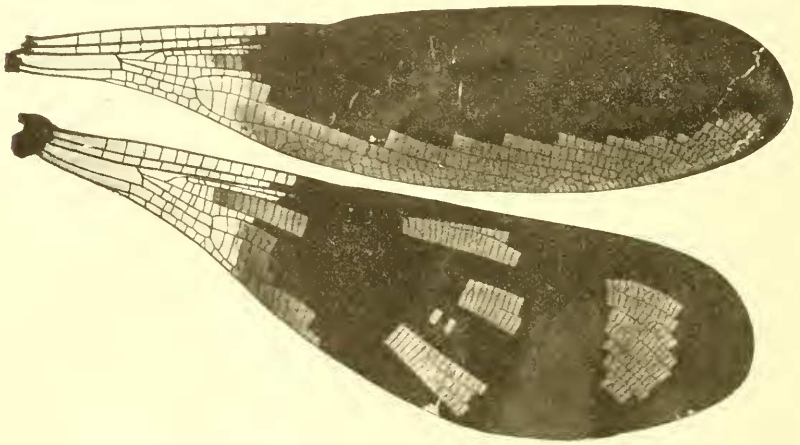


FIG. 8.—WINGS OF MALE RHINOCYPHA QUADRIMACULATA FROM BURMA.

posterior lobe with a narrow, sharply defined, longitudinal median yellow stripe; thorax black, median triangular area reaching the antealar sinus, pink in color, narrower than in *fenestrella*, the sides slightly concave. Lateral sclerites with reduced yellow stripes below; these stripes together give the impression of a nearly continuous longitudinal line parallel to the coxæ and extending posteriorly to the first abdominal segment: the stripe on the metepisternum is placed just before the second lateral suture and extends from the metinfraepisternum two-thirds of the distance to the base of the hind wing; humeral suture with the merest yellow streak above. Legs black, femora of the two last pair lighter beneath apically; tibiæ of two last pair with heavy chalky-white pruinescence beneath; pectus black. Wing markings as figured; in the hind wing 3 rows of vitreous spots;

the first row consisting of 2 spots, the anterior spot one-cell wide, lying between  $R_s$  and  $M_3$ , the posterior reaching from  $M_4$  to the hind margin of the wing. The second row consists of 3 distinct spots, the anterior lies between  $M_1$  and  $M_2$ , the middle spot between  $R_s$  and  $M_3$ , and the posterior between  $M_4$  and  $Cu_1$ ; an imperfect spot is present between the middle and posterior spots; undoubtedly in some individuals this disappears and in others a well-marked spot is present, variable as in the case of *fenestrella*. The third and apical row consists of a single large spot lying between  $M_{1a}$  and the first secondary sector anterior to  $M_3$ . Stigma of front wings black, median portion subapically yellowish brown, not sharply defined; of hind wings dorsally black, with nearly half subapically pale yellowish brown, ventrally with the pale area more sharply defined, pale yellow in color. Abdomen black.

Distinguished from *fenestrella* by having the anterior of the median row of spots decidedly nearer the nodus (beginning before  $M_{1a}$ ), with the result that the spot is narrower, and its anterior edge is more bounded by  $M_1$ , while in *fenestrella* the basal anterior border of this spot is more or less formed by  $M_{1a}$ . In *fenestrella*, moreover, the three spots of the median row are about equal in length, while in *quadrимaculata* the middle spot is abbreviated basally about half the length of the other two spots. The large apical spot is, in *quadrимaculata*, not entirely under the stigma as in *fenestrella*, and it is decidedly larger, although this last point will be found undoubtedly subject to great variation since the anterior and posterior borders of this spot in the specimen before me are formed by secondary sectors in both cases; for this apical spot to increase or decrease one cell's width either anteriorly or posteriorly should not be unexpected. Differences in the stigma also exist between *fenestrella* and *quadrимaculata* as pointed out in the key above. In *quadrимaculata* the yellow stripe on the metepimeron is longer than in *fenestrella* and more continuously parallel to the latero-ventral metathoracic carina. *Quadrимaculata* has hitherto been described as larger than *fenestrella*; the now known range in size is abdomen 19–23 mm., hind wing 21–25. I believe *quadrимaculata* is specifically distinct from *fenestrella*, but indistinguishable from *spuria*.

## 6. RHINOCYPHA FENESTRELLA Rambur.

Material studied: Siam, collection U.S.N.M., Trong, Lower Siam, 13 males, 2 females; Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January–February, 1899, 6 males, 5 females. Burma,

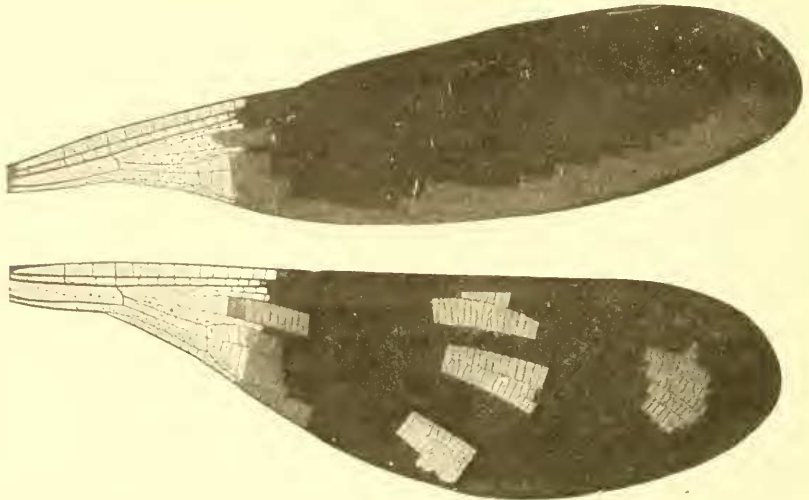


FIG. 9.—WINGS OF MALE RHINOCYPHA FENESTRELLA FROM BURMA.

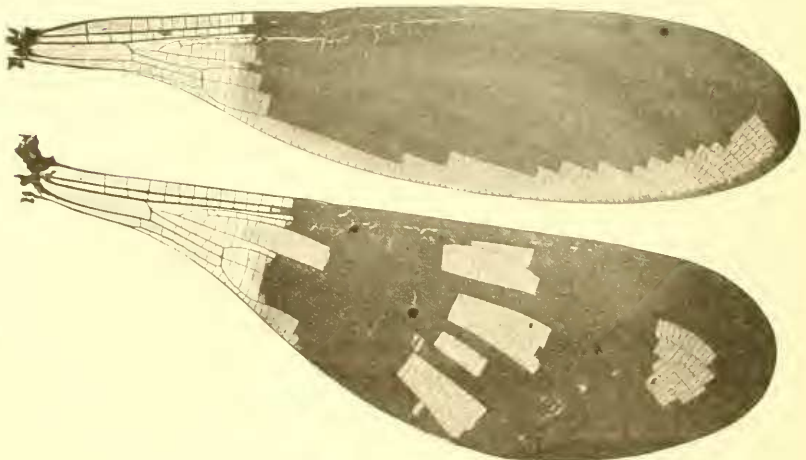


FIG. 10.—WINGS OF MALE RHINOCYPHA FENESTRELLA FROM BURMA.

collection P. A. N. S., 9 males; collection Williamson, 19 males, 4 females.

In this species the vitreous area on the front wings of males behind the opaque area occupies from one-fifth to nearly one-half the wing width. In specimens from Burma and Siam one-fifth to one-third is

most usual. The triangular dorsal area of males is red or blue, or both colors in the same individual. This red and blue are very delicate, comparable almost to the reflections of the vitreous areas of the wings.

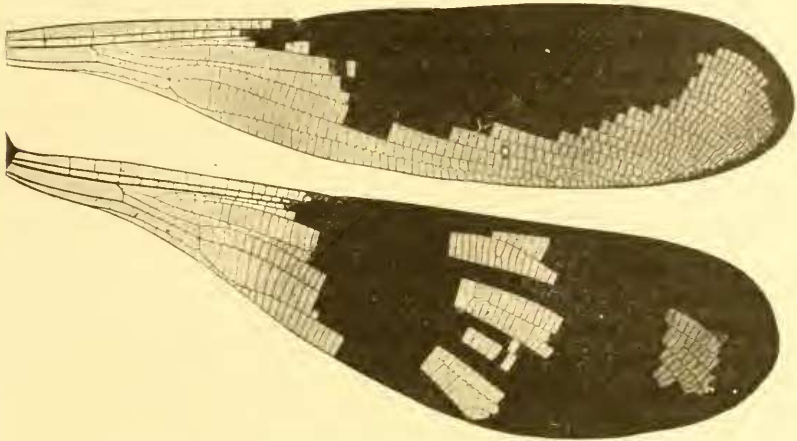


FIG. 11.—WINGS OF MALE RHINOCYPHA FENESTRELLA FROM PERAK.

#### 7. RHINOCYPHA BIFORATA De Selys.

Material studied: Siam, collection U.S.N.M., Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January–February, 1899, 5

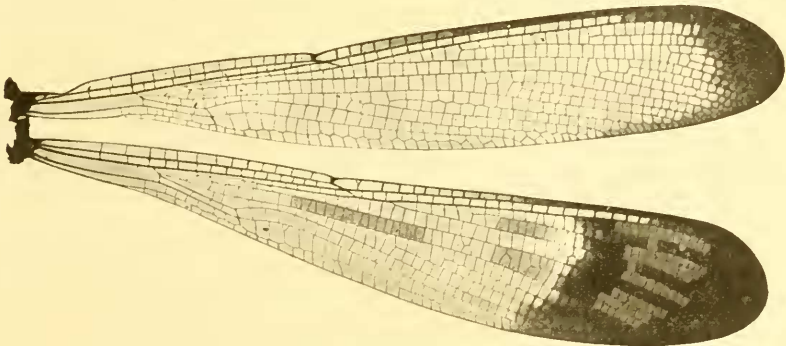


FIG. 12.—WINGS OF MALE RHINOCYPHA BIFORATA FROM SIAM.

males, 2 females. Burma, collection Williamson; a very teneral male seems to belong here.

#### 8. RHINOCYPHA IGNIPENNIS De Selys.

Material studied: Burma, collection Williamson, 1 male.

This single specimen, with the male of *quadrimaculata* described above, was sent to Professor Förster. My opinion was that it represented an undescribed species closely related to *ignipennis*. Profes-

sor Förster writes of this specimen, "Wings not in full color, but perhaps the coloration of the body may indicate a species distinct from the races of *ignipennis*; but this is a very difficult matter to settle." Because of the very scanty material before me I content myself with referring it to *ignipennis* for the present. A description of the single male follows: Abdomen 21 mm.; hind wing 25. Labium yellowish white, black tipped; a large greenish-white spot on either side of labium, between labium and eye; a spot on the outer side of each posterior ocellus and two on the posterior ridge of the occiput, greenish white. The triangle formed by lines connecting these 2 posterior spots and the anterior ocellus has the line between the 2 spots as the longest side; an oblong spot on the rear of the head between the 2 posterior spots. Eyes bronze with purplish reflections above. Rest of head black, shining in front, velvety above.

Prothorax black, anterior lobe with 2 pale bluish spots on either side; middle lobe with 2 larger pale bluish spots on either side; hind lobe with its antero-dorsal surface crescent-shaped and rust red in color. Thorax black above, mid dorsal triangular area short, dark rust-red in color, its base about one-half as long as its sides; on either side of the dorsum is a stripe reduced to an antealar spot above, an ovate spot below, and just below the ovate spot a small round spot, all blue in color. Metepisternum largely blue, this blue variegated below and behind with orange; mesepimeron with a blue stripe just behind the humeral suture, widening below to fuse with the pale color of the metepisternum opposite the metastigma; metepimeron with a large triangular blue spot occupying nearly its entire surface, the blue variegated behind and below with orange. Metasternum black with two lateral longitudinal yellow stripes and apex pale yellowish.

Wings hyaline, apically with the merest trace of brown, which has bronzy reflections; this dark area begins on the front wings between the nodus and stigma and on the hind wings at the nodus. Hind wings with 2 rows of vitreous spots, which are of a pale bluish milk color by transmitted light, and a light iridescent red by reflected light. So slight is the trace of brown on the four wings, as described above, that in this specimen the vitreous spots are the least transparent portions of the wings. This lack of density in the brown is probably due to immaturity, though I detect no other condition in the specimen to indicate this, unless it be the color of the stigma. The vitreous spots are located as follows: first row, consisting of one spot 9 cells long, has its basal end just beyond the nodus and is placed between  $R_8$  and  $M_3$ , which sectors bound anteriorly and posteriorly the middle spot of the 3 spots of the second row of vitreous spots; anterior spot of second row placed between  $M_{1a}$  and  $M_2$ ; and the posterior spot between  $M_4$  and  $Cu_1$ . All four of the spots are similar in size and shape, the middle one of the second row somewhat the largest, all



about 8 to 12 cells long; the second row is placed at about two-fifths the distance from nodus to stigma; stigma with basal half black, apical half white, bounded by black veins. Legs black. Abdomen black; segment 1 with a large blue spot on either side; segments 2-9 each with a lateral basal blue spot, relatively larger anteriorly where it is ovate in shape extended forward on the side of the segment, posteriorly becoming successively smaller and more rounded; segments 2-7 each with a small short pale streak below on the side near the middle of the segment. This specimen differs from *ignipennis* as described by having the brown area on the wings less extensive, in the position of the first vitreous spot, in the color of the stigma, and in body markings; it differs less from *ignipennis* than from any other species known.

#### 9. RHINOCYPHA IRIDEA De Selys.

This species is not represented in the material before me. De Selys has recorded it from Leitò in May and Puepoli in June.

#### 10. ANISOPLEURA FURCATA De Selys.

Described from a single male taken by Fea at Puepoli, in June. My collection from Burma contains a crushed teneral female of a

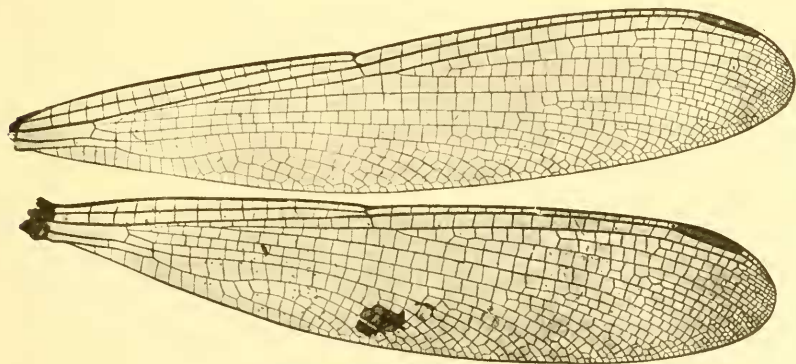


FIG. 13.—WINGS OF FEMALE ANISOPLEURA FURCATA FROM BURMA.

species of *Anisopleura*. This female has the abdomen 30 mm. in length and the hind wing 30. Its condition is such as to make a description impossible.

#### 11. EUPHÆA OCHRACEA De Selys.

Material studied: Burma, collection P. A. N. S., 1 male. - Siam, collection U.S.N.M., Trong, Lower Siam, 3 males, 1 female; Khaw Sai Dow Mountain, 1,000 feet, Trong, January-February, 1899, 4 males, 3 females.

This species is distinguished from the next, *masoni*, by having the wings more or less yellow or reddish yellow, and the anal area behind

the medio-anal link, and for the distance of a few cells apically, one cell wide. General males have the slightest tinge of yellow on the wings; females have a tinge of color in the costal and subcostal

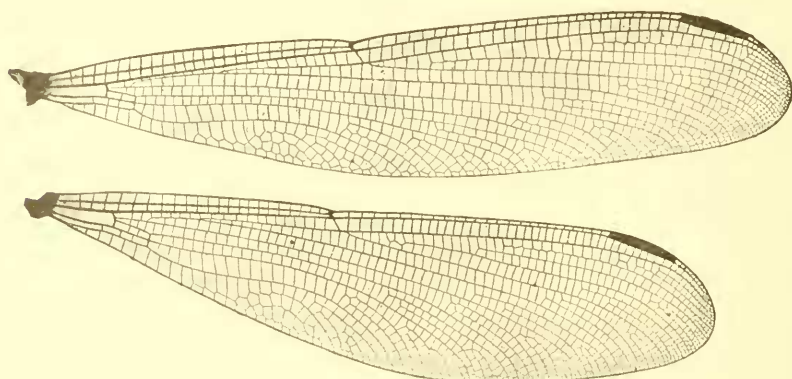


FIG. 11.—WINGS OF MALE *EUPHÆA OCHRACEA* FROM SIAM.

spaces. The single male from Burma has the hind wings slightly wider and more distinctly hyaline (without yellow) at the apex than specimens from Siam. De Selys recorded this species for Puepoli and Leitò (April, May, and June), and Cobapò (September).

12. *EUPHÆA MASONI* De Selys.

In the Burmanese collection belonging to the Philadelphia Academy of Natural Sciences is a single male of this species, which sex is at once distinguished from the preceding species by having the wings largely brown or black, and the anal area behind the medio-anal link 2 cells wide. This male has the abdomen 34 mm. in length, and the hind wing 27. A male from Tonkin, in my collection, has these parts respectively 38 and 32 mm. The Burmanese specimen has the costal space of the front wings half way to the nodus and the basal space of the hind wings largely hyaline. Mr. Kirby has recorded the species for Upper Burma.

13. *DYSPHÆA LIMBATA* De Selys.

Trong, Lower Siam, 1 male, collection U.S.N.M.

Wings with about the basal half black, the apices black tipped; the opaque on the front wings reaches to the nodus in the costal and subcostal spaces, the area posterior to the subcostal space reaching to within about 3 cells of the nodus; edge of opaque area straight till near the hind border, when it turns basally; postnodal costal space slightly tinged; hind wings opaque to 9 or 10 cells beyond the nodus, continued in the costal space to the wing tip, edge of opaque area straight, turned basally near the hind margin as in the front wings; tips of all four wings, to 1 or 2 cells under the stigma, black; edge of black tip straight, parallel to the edge of the basal opaque areas.

Abdomen 37 mm.; hind wing 31. The species has been recorded from Malacca, Malay Peninsula, Borneo, and Sumatra.

14. *VESTALIS SMARAGDINA* De Selys.

This species has been reported from the Khasia Hills, Burma, and eastern Thibet. In Burma De Selys has recorded it for Cobapò and Meteleò (September and October), Iadò in December. It is about the same size as *amaena*, from which it may be distinguished by having the sides of the thorax posteriorly yellow, the same parts being metallic green in *amaena*. *Smaragdina* is known to me only from descriptions.

15. *VESTALIS AMOËNA* Hagen.

Material studied: Siam, collection U.S.N.M., Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January–February, 1899, 4 males; Trong, lower Siam, 2 males, 4 females.

Abdomen, male 46 mm.; female 40; hind wing, male and female 35. One row of cells between  $Cu_1$  and  $Cu_2$ , excepting near their termination at the wing margin. The color of mouth parts and antennæ vary greatly, apparently with age and sex, younger individuals and females having the pale areas more extensive. The species occurs also in the Malay Peninsula, Sumatra, Java, and Borneo.

16. *VESTALIS GRACILIS* (Rambur).

Material studied: Burma, collection, P. A. N. S., 1 male; collection Williamson, 2 males, 5 females. Siam, collection U. S. N. M., Trong, Lower Siam, 1 male, 1 female.

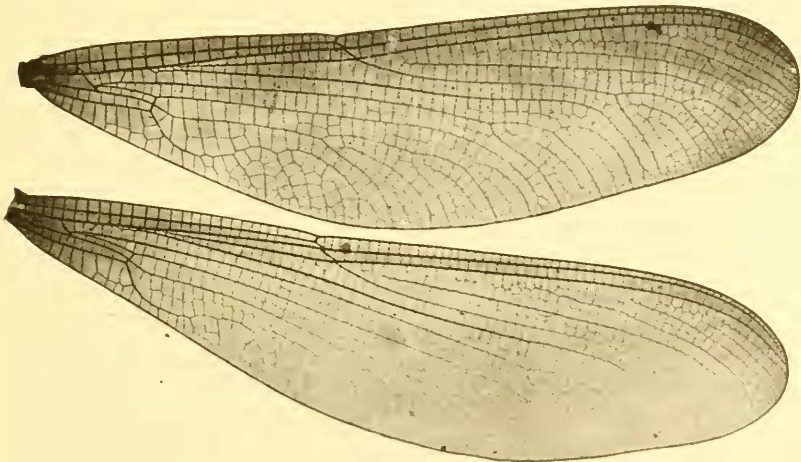


FIG. 15.—WINGS OF MALE *VESTALIS GRACILIS* FROM BURMA.

Abdomen, male 56 mm., female 49; hind wing, male and female 40. Two rows of cells between  $Cu_1$  and  $Cu_2$  for at least a short distance

from their origin, followed by one row, this single row breaking up near the wing margin as in *amana*. De Selys records the species for Palon (August and September) and Leitò (May). He states that the species occurs also in India, Thibet, and Cochin China.

#### MNAIS De Selys.

The Palearctic and Oriental species of this genus may be separated as follows:

Abdomen slender; stigma small, squarish, less brilliant, similar in adults of both sexes; wings more expanded,  $Cu_1$  ending about or before the level of the nodus; stigma followed normally by one row of cells. Oriental.

Abdomen more robust; stigma twice as long as wide, red in the male, white in the female; wings less expanded,  $Cu_1$  ending beyond the level of the nodus; stigma followed by 2 rows of cells. Palearctic.

#### 17. MNAIS ANDERSONI McLachlan.

Material studied: Burma, collection P. A. N. S., 2 males, 2 females.

This species was originally described from Yunnan from 2 males, one of which, the first described, had the venation black and the wings slightly tinged with olivaceous, the other having the wings yellowish red.

De Selys<sup>a</sup> writes that conditions exist intermediate between the olivaceous and yellow forms. I have before me 28 specimens of *Mnaïs* from Burma, and there are no intermediate forms. I therefore retain the name *andersoni* for the black-veined species, which may be described as follows: Abdomen, male 42 mm., female 37; hind wing, male 33 mm., female 32. Venation black, wing membrane very slightly tinged with olivaceous. The 2 males before me have the last 3 segments of the abdomen pruinose, the dorsum of the thorax not pruinose; the second segment of the antennæ is less than half yellow, and the stigma is smaller than in the yellow-winged species. The 2 females listed under "material studied" are referred to this species solely because they were associated with the males. They are green, bronzy, especially on the thorax and last abdominal segments; the second segment of the antennæ is largely yellow and the stigma is dull red.

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<sup>a</sup>Odonates de Birmanie, p. 485.

18. *MNAIS EARNSHAWI*, new species.

Material studied: Burma, collection Williamson, 22 males, 2 females. Abdomen, male 40 mm., female 34; hind wing, male 33 mm., female 30.

*Male*.—Venation yellowish red throughout, excepting that the costa becomes darker toward the wing base, wing membrane throughout tinged with bright yellow, slightly paler basal to the areculus and slightly denser along the anterior half of the wing on either side of the nodus, throughout with bright pink and violet reflections. The last 3 segments of the abdomen not pruinose in 6 of 17 specimens; the dorsum of the thorax pruinose in 19 specimens, but not pruinose in 1 very teneral individual. So far as my material goes this difference in pruinescence seems to clearly indicate specific differences between *andersoni* and *earnshawi*; in the case of *andersoni* the pruinescence is first

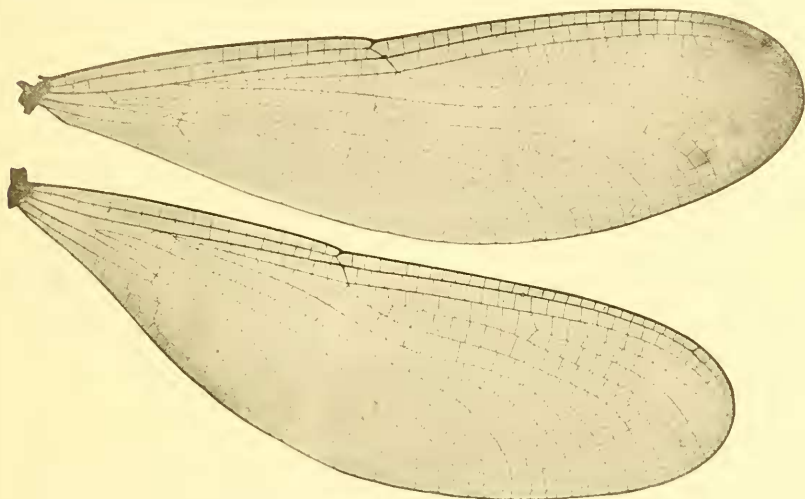


FIG. 16.—WINGS OF FEMALE *MNAIS EARNSHAWI* FROM BURMA.

clearly marked on the last abdominal segments, and if it appears at all on the thorax it is at a stage of maturity not reached by the 2 apparently mature males I have seen; *earnshawi*, on the other hand, becomes pruinose first on the thorax, and it is only in more mature individuals that the pruinescence appears on the abdomen. Of 40 antennae of *earnshawi* examined 13 had the second segment about  $\frac{1}{2}$  yellow, while 27 had this segment more than  $\frac{1}{2}$  yellow. Of 70 wings of this species 7 wings had two rows of cells for at least a short distance in the poststigmal costal space. A very teneral male has the wings and stigma pale salmon in color. The 2 females in this case, as in the case of *andersoni*, are referred to *earnshawi* only because of their association with the males. One of them, somewhat teneral, has the body colors bright green throughout; the second segment of the antennae is yellow, excepting an apical point; and the stigma is dull white. In the other female the stigma on one front wing is all but wanting, being reduced

to a mere irregular speck of opaque tissue on either side of a postnodal cross vein. This female has the stigma dull reddish-brown in color.

The species is named for Mr. R. A. Earnshaw, Toungu, to whose friendly interest in obtaining material for me it is a pleasure to testify.

In discussing *M. andersoni*, De Selys<sup>a</sup> says:

Leitô en avril et mai, Cobapô en septembre, octobre et novembre, Meteleô et Puepoli en septembre et octobre. Les exemplaires à réticulation et ailes sofrancées viennent de Cobapô au commencement de juin et d'octobre, un exemplaire moins prononcé de Iadô le 12 avril (Fea).

Male specimens of *Mnais strigata*, *costalis*, *andersoni* and *earnshawi* placed side by side indicate beautifully the parallel development of the genus in the two zoogeographical areas, *andersoni* suggesting *strigata* (from Japan), and *earnshawi* suggesting *costalis* (from Japan). With this parallelism in mind the coloration of the wings in this genus becomes an important specific character.

19. CLIMACOBASIS MODESTA (Laidlaw).

Material studied: Siam, collection U.S.N.M., Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January-February, 1899, 2 males, 3 females; Trong, Lower Siam, 3 males.

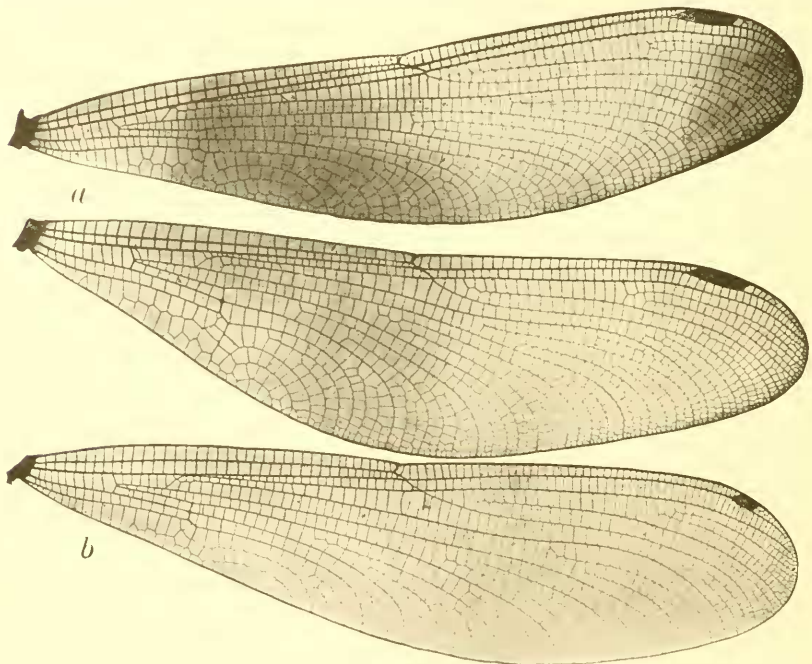


FIG. 17.—WINGS OF CLIMACOBASIS MODESTA FROM SIAM. a, MALE; b, FRONT WING OF FEMALE.

In Mr. Laidlaw's description of *Climacobasis buyens* (= *modesta*) the male is described as having the hind wing 47 mm. in length. Doubt-

<sup>a</sup>Odonates de Birmanie p. 486.

less this is a mistake, 37 being intended. A male and female from Siam measure as follows: Abdomen, male 54 mm., female 46; hind wing, male 39 mm., female 41. Wings of both sexes have the violet and green reflections almost universal in this subfamily.

20. *NEUROBASIS CHINENSIS* (Linnæus).

Material studied: Burma, collection P. A. N. S., 2 males; collection Williamson, 3 males. Siam, collection U. S. N. M., Trong, Lower Siam, 6 males, 3 females; Khow Sai Dow Mountain, 1,000 feet, Trong, Lower Siam, January-February, 1899, 1 male.

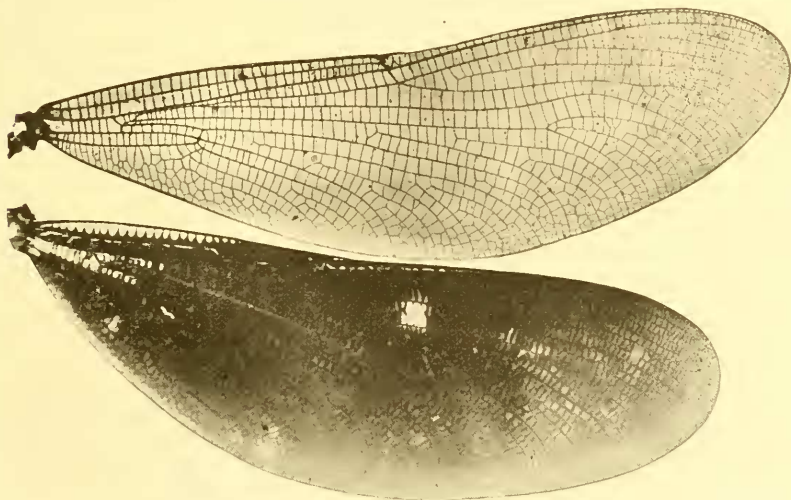


FIG. 18.—WINGS OF MALE *NEUROBASIS CHINENSIS* FROM SIAM.

De Selys in *Odonates de Birmanie* records *chinensis* from "Monts Carin en avril; Puepoli en juin; Blamo en juillet (Fea)." Mr. Kirby has recorded the species for Upper Burma and Hassan Abdal. Mr. Laidlaw took the species on the Aring River, in Kelantan; and De Selys in 1897 (Causeries Od.) gives as "Patrie: Inde, Thibet, Khazya Hills, Cochinchine, Sumatra, île du Prince-de-Galles."

21. *MATRONA NIGRIPECTUS* De Selys.

This species is not represented in the material before me. De Selys has recorded it from the Khasia Hills, Puepoli (June) and Leitò (September).

SUMMARY.

Twelve genera and twenty-one species of the subfamily Calopteryginae are known from Burma and Lower Siam. In the preparation of this paper a total of 233 specimens have been studied,